

COMMUNICATION EFFICIENCY

FIELD

[0001] The invention relates generally to improving communication efficiency of a wireless communication system.

BACKGROUND

[0002] Transmission control protocol (TCP) is one of the protocols in the internet protocol (IP) suite. The TCP, and other transport layer protocols, may be used to deliver data streams between programs running on computers connected to internet, for example. The TCP may control the transmission by dividing the data to be transmitted into segments and by forwarding the segments to an IP layer, which encapsulates each data segment into an IP packet. Thereafter, the IP packet may be transmitted to the receiver. However, the current manner of generating the data segments may not provide an efficient communication between the transmitter and the receiver.

BRIEF DESCRIPTION OF THE INVENTION

[0003] According to an aspect of the invention, there is provided a method as specified in claim 1.

[0004] According to an aspect of the invention, there are provided apparatuses as specified in claims 10 and 21.

[0005] According to an aspect of the invention, there is provided a computer program product as specified in claim 20.

[0006] According to an aspect of the invention, there is provided a computer-readable distribution medium carrying the above-mentioned computer program product.

[0007] According to an aspect of the invention, there is provided an apparatus comprising means for performing any of the embodiments as described in the appended claims.

[0008] Embodiments of the invention are defined in the dependent claims

LIST OF THE DRAWINGS

[0009] In the following, the invention will be described in greater detail with reference to the embodiments and the accompanying drawings, in which

[0010] FIG. 1 presents a network, according to an embodiment;

[0011] FIGS. 2 and 10 show methods, according to some embodiments;

[0012] FIG. 3 shows example TCP streams, according to an embodiment;

[0013] FIG. 4 illustrates how there may be limitations for selecting the maximum segment size (MSS) for a given communication path, according to an embodiment;

[0014] FIGS. 5A and 5B illustrates some examples on how some performance parameters may affect the selection of the MSS, according to some embodiments

[0015] FIG. 6 depicts how thresholds may be used in selection of a TCP stream, according to an embodiment;

[0016] FIGS. 7 and 8 illustrates how a terminal may control the use of the TCP streams, according to some embodiments; and

[0017] FIG. 9 illustrates an apparatus, according to an embodiment.

DESCRIPTION OF EMBODIMENTS

[0018] The following embodiments are exemplary. Although the specification may refer to “an”, “one”, or “some” embodiment(s) in several locations of the text, this does not necessarily mean that each reference is made to the same embodiment(s), or that a particular feature only applies to a single embodiment. Single features of different embodiments may also be combined to provide other embodiments.

[0019] The number of IEEE 802.11-enabled mobile devices is increasing. The IEEE 802.11 is a set of standards for implementing wireless local area network (WLAN), also known as the Wi-Fi. Such an IEEE 802.11-enabled station (STA), such as user terminal/equipment 100 in FIG. 1, may associate and communicate with an access node/point (AP) 102, 104. The STA 100 may comprise a mobile phone, a palm computer, a wrist computer, a laptop, a personal computer, or any device capable to access the wireless radio access network, such as the WLAN. The access node 102, 104 may be a WLAN (IEEE 802.11) access point (e.g. Wi-Fi base stations), for example. Each station 100 and the AP 102, 104 may apply a transport layer protocol, such as a transmission control protocol (TCP), for transmitting data over the network. The TCP may reside on a transport layer in an internet protocol (IP) suite. As said, the TCP may be responsible of generating data segments for transmission as IP packets, for example.

[0020] Another radio communication network, such as the Long Term Evolution (LTE) or the LTE-Advanced (LTE-A) of the 3rd Generation Partnership Project (3GPP), may also be present in the area. Such cellular communication network is typically composed of at least one base station 106 providing coverage to a cell covering a geographical area. The base station 106 may be, e.g., a node B (NB) as in the LTE or an evolved node B (eNB) as in the LTE-A.

[0021] In presence of several access nodes 102-106 (i.e. the APs 102, 104 and the eNB 106), the STA 100 may have an option of a communicating with another node 108 in the network through a multipath TCP (MP-TCP). One of the aims of the MP-TCP may be to allow a TCP connection to use one or many communication paths 112-116 to maximize resource usage and increase communication efficiency. However, different communication paths 112-116 may have different communication performances, such as physical layer (PHY) transmission rates and transmission errors. Similarly, the situation in a single communication path may vary in time.

[0022] The difference of the minimum and maximum (PHY transmission rate of, e.g., wireless radio access network (WLAN) radio is becoming very large. The lowest transmission rate may be 1 Mbit/s in the legacy 802.11b. In an orthogonal frequency division multiplexing (OFDM) based 802.11a, the lowest transmission rate may be 6 Mbit/s while the highest transmission rate of the 802.11ac may be 5 Gbit/s. Therefore, it may be beneficial to have multiple TCP connections available for a single communication path.

[0023] Similarly, the size of the transmitted packets, such as a Physical Layer Convergence Protocol (PLCP) Protocol Data Unit (PPDU), may vary. E.g. it may be possible to aggregate multiple medium access service (MAC) Service Data Units (MSDUs) to a single transmitted PPDU. Such frame aggregation mechanisms may create larger transmitted PPDUs. The PPDUs with large payload may require longer transmission periods than shorter PPDUs. However, owing to such aggregation, the overheads due to data preamble and acknowledgements transmissions may be reduced.